

THE DECOMPOSITION OF THE CONTENTS OF THE DENTINAL TUBULES AS A DISTURBING FACTOR IN THE TREATMENT OF PULPLESS TEETH.

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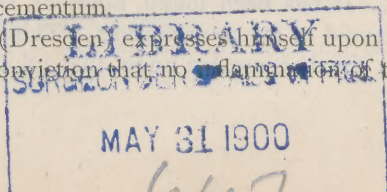
IN many of the recent discussions on the treatment of pulpless teeth or teeth with foul pulps, particular stress has been laid upon the supposed necessity of pursuing such a course of treatment as will bring about a complete sterilization of the contents of the tubuli in the dentine of the root. It has been claimed that otherwise decomposition of such contents will follow, gases and other products of putrefaction will work their way through the dentine and cement and keep up a perpetual bombardment upon the pericementum, resulting in chronic or possibly acute inflammation of the same.

These claims do not appear to me to be in accord with clinical experience, nor are they, as far as my knowledge of the literature of the subject goes, based upon experimental evidence. It has been my experience that in all cases where we have a straight wide canal, so that we can remove all traces of the pulp and thoroughly cleanse the canal, regardless of the tubuli, we may count upon success with almost, if not quite, absolute certainty.

In proportion as the canal becomes narrower and tortuous, rendering the thorough cleansing difficult or impossible, in the same degree the probability of a successful treatment will be diminished. It is a matter of continual experience that an inflammation of the pericementum, either acute or chronic, will disappear with astonishing rapidity upon the total extirpation of the putrid pulp and application of almost any antiseptic, which would scarcely be the case if the decomposition of the contents of the tubuli were an important factor in the disturbance. Again, in all cases where trouble has arisen after treatment I have been able to trace it either to irritation of the periapical tissue by careless treatment or over-treatment, or to an imperfect cleansing of the canal.

What, however, from a clinical aspect seems to tell most strongly against such a view is the fact that trouble subsequent upon filling occurs invariably first at the point of the root, where it may remain localized or spread to a greater or less portion of the pericementum, whereas any trouble arising from the decomposition of the contents of the tubuli we should expect to begin near the neck of the tooth, where the decomposition must first take place, if at all, and where, on account of the thinness of the cement, the gases might most easily penetrate to the pericementum.

Dr. N. S. Jenkins (Dresden) expresses himself upon this subject as follows: "It is my conviction that no inflammation of the pericementum



tum takes place when the pulp has been *thoroughly* extirpated, and the canal, pulp-chamber, and crown cavity *properly* filled. I have never known a case where there was any reason to suspect pericemental inflammation to be caused by the decomposition of the contents of the dentinal tubules. The inflammation could always be more reasonably accounted for, it invariably seeming to be the result of defective manipulation or of pre-existing necrosis."

It is not my intention, however, to discuss this problem from a clinical point of view, but rather to give the results of a few investigations of a scientific nature which I have made in reference to this question, and the conclusions which may be drawn from them.

In the first place, we must bear in mind that the only decomposition which could take place in the dentinal tubules is one which might be brought about by bacteria; in other words, putrefactive decomposition, or simply putrefaction. In the event of such a decomposition of the contents of the tubuli taking place, a great variety of substances might be produced, chiefly, however, ammonia (NH_3), sulphuretted hydrogen (SH_2), hydrogen (H), carbonic acid (CO_2), a variety of acid and alkaline substances such as formic, lactic, acetic, and butyric acids, carbonate of ammonia, propylamine, trimethylamine, etc., and finally the ptomaines.

It must not be supposed, however, that all these substances would be produced in any one case. How many of them might be formed would depend upon whether it were a pure or a mixed infection,—*i.e.*, whether the tubules had been invaded by one or more kinds of bacteria.

The products of decomposition arising from the action of a single kind of bacterium are, according to the few observations yet made, limited in number, stinking gases being most frequently represented, then peptone, ammonia, trimethylamine.

Nor should it be taken for granted that the quantity of gas produced in a case of putrefaction must necessarily be very great; as a rule it is insignificant when compared with the amount of gas produced by the fermentation of carbohydrates.

Bearing in mind that the putrefaction of the contents of the tubules can take place only under the action of micro-organisms, naturally the first question to be answered is, Whether and to what extent do micro-organisms from the root-canal penetrate the dentinal tubules?

At first thought the probability of an extensive invasion of the tubuli does not appear very great. The diameter of the normal tubuli, particularly in the root, is, it is true, considerably greater than that of most bacteria, so that on this score there would be nothing to prevent their entrance. It has been found, however, that the putrid dental pulp is often devoid of micro-organisms. This condition is not difficult to account for, because we know that all the nourishment con-

tained in a pulp may soon be exhausted, and where the pulp-chamber is closed so that no fresh material is admitted from without, the micro-organisms may perish from want of nourishment, or they may be devitalized by the prolonged action of their own products. These two causes would also operate in a much higher degree in the narrow tubuli of the dentine. Add to this the fact that the access of air must be exceedingly limited, so that the aërobic bacteria could probably not live in the tubules for any length of time, and I think we would be justified, *a priori*, in regarding the tubules of sound dentine as not particularly favorable media for the cultivation of bacteria.

These are, however, only theoretical considerations; the question as to whether an invasion of the tubules actually takes place or not can be settled by microscopical examination alone.

With this object in view I prepared sections of nineteen roots, all of which, with one exception, contained remains of putrid pulps, while four of them were abscessed.

The roots were sawed into lamellæ about one millimeter* thick and placed in a ten per cent. solution of hydrochloric or nitric acid, in which they became softened in a few hours. They were then soaked in water (repeatedly changing) to remove the acid, cut on the freezing microtome, stained by the Günther modification of the Gram method, and mounted in the usual manner in Canada balsam.

The examination of these sections revealed in many of them a condition which, while being well known to be the normal condition in the tusks of elephants, for example, has not, I believe, attracted attention in the human teeth.

In ten of the roots examined I found the canal to be completely or partially lined with a substance of a homogeneous or globular structure, containing very few or no canals but occasionally a formation resembling a bone-lacuna, and on the whole bearing much more resemblance to cement than to dentine† (Fig. 1). This layer is impermeable to micro-organisms, and acts, therefore, as a safeguard against the decomposition of the contents of the tubuli.

Open roots which serve as retaining centers for food-particles undergo the natural process of decay, by which the lumen of the canal is gradually increased. The phenomena of decay here are the same as those in decay of the dentine of the crown and neck of the tooth. A cross-section under low power is given in Fig. 2.

A microscopical examination of the sections prepared as above stated gave the following results:

No. 1. Section near open end of root showed decay and extensive infiltration of the tubules; section near apex appeared lined with the

* One millimeter equals about $\frac{1}{25}$ inch.

† The capacity of the pulp to form other structures than dentine will be discussed in my articles on the tusks of the elephant.

impermeable modified dentine, except at one point, where a few cocci may be seen in eleven of the tubules.

No. 2. Two sections from near the middle of the root ; both show the modified dentine. In one piece four tubules are infected, in the other none.

No. 3. Sections near the open end of the root show decay ; those near the apex are lined on one side of the canal by impenetrable modified dentine without tubules ; on the other side four tubules contain a few cocci.

No. 4. Inner layer again destitute of tubules ; no infiltration whatever. (See Fig. 1.)

FIG. 1.

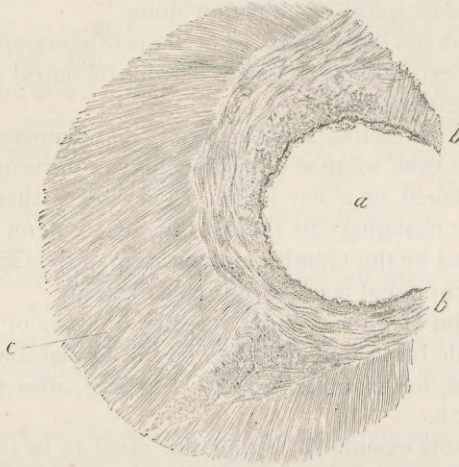


FIG. 1.—Portion of a cross-section of a root containing the remains of a putrid pulp. *a*, root-canal ; *b*, modified impenetrable dentine lining the canal ; *c*, normal dentine. No trace of infection.

No. 5. Section near open end decayed ; section near apex shows about one-fourth of the canals infected with straggling cocci to a depth of one-fourth to one-half millimeter.

No. 6. The end section is slightly decayed and correspondingly infected. The section near the apex is protected on one side by tubeless dentine ; on the other side eighteen tubules are infected by a few straggling bacilli to a depth of one-half to three-fourths millimeter (Fig. 3). A few of the tubules contain also cocci (Fig. 3, *a*, *b*), from which we must conclude either that the dentine is infected with two kinds of bacteria or with a pleomorphous bacterium.

No. 7. The root in this case contained an inflamed pulp ; no trace of tubular infection is anywhere to be discovered.

No. 8. Section from about middle of root ; twenty-six of the tubules are infected with cocci to a depth of about one-tenth millimeter. (See Fig. 4.)

No. 9. The sections show again that the canal is in part lined with modified dentine. In two or three tubules only was I able to find about a dozen bacteria. The root was abscessed.

FIG. 2.

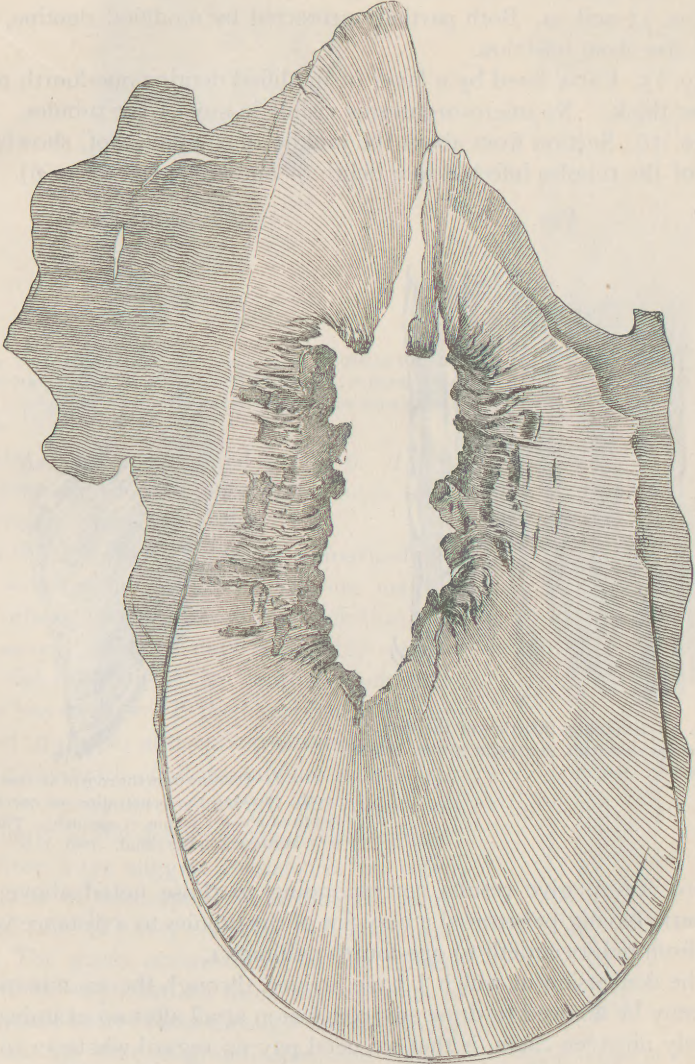


FIG. 2.—Cross-section of the posterior root of a lower molar, showing the advance of decay from the canal. 20 : 1.

No. 10. The canal was found filled with masses of bacteria (see Fig. 5), but no infection of the tubules worth mentioning could be detected, only a few cocci being visible in three or four tubules. The canal was again partly lined with modified dentine. Root abscessed.

No. 11. Abscessed root. Section near the pulp-chamber shows nearly all the tubules infected to the depth of one-tenth to one-fourth millimeter. Section near apex free from infection.

No. 12. Ground section from near the middle of the root; no infection of the tubules whatever.

Nos. 13 and 14. Both partially protected by modified dentine, and both free from infection.

No. 15. Canal lined by a layer of modified dentine one-fourth millimeter thick. No micro-organisms visible in any of the tubules.

No. 16. Section from about the middle of a small root, showing a few of the tubules infected to a depth of one millimeter (Fig. 6).

FIG. 3.



FIG. 3.—Straggling infection of the dentine of a root with bacilli, at a point $\frac{3}{4}$ mm. below the surface. 1000 : 1.

FIG. 4.

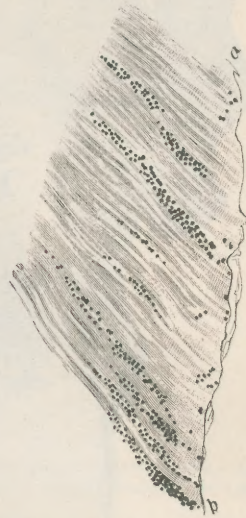


FIG. 4.—Dentine from the root of an abscessed tooth, showing the penetration of cocci to a depth of about 1-10 mm. (1-250 inch). The side *a*, *b*, bordered on the canal. 1000 : 1.

Nos. 17-19 give results corresponding to those noted above, the bacteria having penetrated a very few of the tubules to a distance varying from one-twentieth to one-fourth millimeter.

The conclusion at which I have arrived through the examinations, if I may be allowed to draw any conclusion at all after an examination of only nineteen cases, is that we need pay no regard whatever to the contents of the tubules in the treatment of root-canals. The tubular infection is so superficial and so slight that an action upon the pericementum appears to me to be altogether out of the question. The first glance at the preparations under the microscope at once impresses one with the utter inadequacy of the infection to perform the action attributed to it. Of the cases I examined, the only one in which there

could be at all a possible question of a deleterious action produced upon the pericementum by a decomposition of the contents of the

FIG. 5.



FIG. 5.—Dentine lining the canal of an abscessed root. *a*, *b*, side bordering on canal; *c*, modified dentine; *d*, normal dentine; *e*, masses of cocci. No penetration of the tubules here visible.

tubules is that represented in Fig. 6. Let us see what are the probabilities that such an action really existed.

In the first place, it may be remarked that the root was not abscessed as were many of the others, which showed less infection. In the second place, we may reasonably suppose that the infection of the dentine would have been less extensive if the canal had been subjected to proper antiseptic treatment; as it is, about one-tenth of all the tubules contain bacteria more numerous toward the canal, very sparingly in the deeper parts of the dentine.

Three ways suggest themselves by which products of decomposition forming in the infected zone (*d*) may reach the pericementum:

1. The gases accumulating in the tubules might be supposed to force the contents of the tubuli before them through the narrowing tubules, the stratum granulosum, and cement directly upon the pericementum. Personally, I place such a process entirely out of the question for the following reasons: There is no trace whatever of any change to be detected in the structure of the dentine which might indicate a development of gas in the tubules. Again, looking at Fig. 6, we find the

FIG. 6.



FIG. 6.—Sector of a cross-section from a diseased root. *a*, cement; *b*, stratum granulosum; *c*, very narrow and finely branched tubules; *d*, infected district. 150: 1.

tubules gradually narrowing and becoming finely branched as we approach the cement, and, bearing in mind that the contents of these tubules not being infected cannot have undergone any change, we will find it impossible to explain how products of decomposition from the infected district could force the contents of the tubules through the gradually narrowing canals, through the stratum granulosum, and through the cement to the pericementum.

2. Gases may break up the union between the fibrils and the walls of the tubules, and so, without dislodging the contents of the tubules, make their way gradually along the tubuli, etc., to the pericementum. Aside from the fact that the sections reveal no trace of such action, I conceive that it would require an enormous pressure to force bubbles of gas from the zone *d* to the surface of the cement.

3. The most probable and, I think, the only way in which gases might possibly be supposed to penetrate from the decomposing fibrils to the pericementum is by a process of diffusion. This, naturally, would apply only to such gases as are soluble in the fluids of the tubules. That an action of this nature does take place will be witnessed to by the fact that in drilling into a tooth containing a putrid pulp, *as we near the pulp-chamber*, the borings will sometimes be found to have an odor of putrefaction. I have not observed, however, that this odor could be detected from the more superficial layers of dentine, though Dr. Jenkins writes me that in chalky teeth he has noticed the odor soon after boring through the enamel. Now, it is quite possible that a similar action, in a diminished degree, may take place through the solution and subsequent diffusion of gases generated in the tubules themselves, though such an action would always remain insignificant when compared with the absorption of gases from the pulp itself; and the possibility that the whole substance of the root may in this way become permeated with the products of decomposition, and to such an extent that they should have an irritating action upon the pericementum, is very slight indeed.

In conformity with the observations which I have made in practice and with the results of my theoretical and experimental examination of this subject, I am in the habit of utterly disregarding the contents of the tubuli. If I am able to thoroughly extirpate the pulp and antiseptically cleanse the canal, I have nothing to fear or to anticipate through decomposition of the contents of the tubuli.

To those who may be of a contrary opinion I would suggest that the only way for them to fill canals is to close the foramen with cement, gutta-percha, or some similar material, and then fill the canal with a substance such as pulverized charcoal, which will absorb the gases which they believe to be formed in the tubuli.